St. Croix National Scenic Riverway
Zebra Mussel Monitoring and
Support of Federally-Listed Endangered Mussel Species
2012 Final Report

from the National Park Service (NPS)
to the U.S. Army Corps of Engineers (USACE)

Project Background:

The St. Croix National Scenic Riverway was the first unit of the National Park System, included in the Wild and Scenic Rivers Act of 1968. The Riverway is considered a nationally significant resource for its richness and abundance of freshwater mussels (approximately 40 species, the greatest in the Upper Mississippi River watershed) and is recognized for its outstanding recreational and biological assets. The diversity of unionids within the Riverway is well documented, and many threats to that diversity have been identified. This faunal group will be severely impacted by a zebra mussel infestation and from other invasive species. Freshwater mollusks are a keystone faunal group of freshwater systems, and their potential loss is unacceptable.

To understand the invasion of zebra mussels into the St. Croix River, measurements of density have been taken within the known infestation zone (the lower 21 miles of river). Anecdotal evidence from the Upper Mississippi River suggested zebra mussel colonization predominates on native mussel beds, especially when substrates are less favorable for recruitment (i.e., sand, silt, etc.). Therefore, sample locations were chosen based on native mussel bed survey work previously conducted by the Minnesota Department of Natural Resources (MN DNR). Eight locations were identified from Stillwater, Minnesota, to Prescott, Wisconsin, reflecting the range of habitats and hydrology found in the infestation zone. Densities of zebra mussels at these locations have been tracked since 2004. The NPS continued this work as in previous years, sampling in August 2012. Processing of data occurred in January with analysis and interpretation a focus of this report.

In addition to understanding relative abundance of zebra mussels in Lake St. Croix, other activities within the St. Croix River basin related to zebra mussels and work with endangered native mussels are covered herein.

Plankton tows and integrated water sampling, both for veliger detection, continued this year as part of a broader determination of reproduction of zebra mussels throughout the Upper Mississippi River system. This monitoring is critical as a complement to other projects in the basin in determining effects of the infestation. For the fourth consecutive year veliger samples will be collected at fifteen lakes within the St. Croix River watershed within Minnesota and Wisconsin identified as high risk for zebra mussel infestation.

The St. Croix Riverway Scuba Dive Team participated in activities related to the native mussel fauna within the river. The NPS committed divers for to aid in the collection and aggregation of

winged mapleleaf mussels within the Interstate state parks. High water prevented the collection of these mussels during the acceptable pre-spawning period, however. In September, winged mapleleaf gravid females were retrieved for propagation in suitable numbers, despite the lack of aggregation.

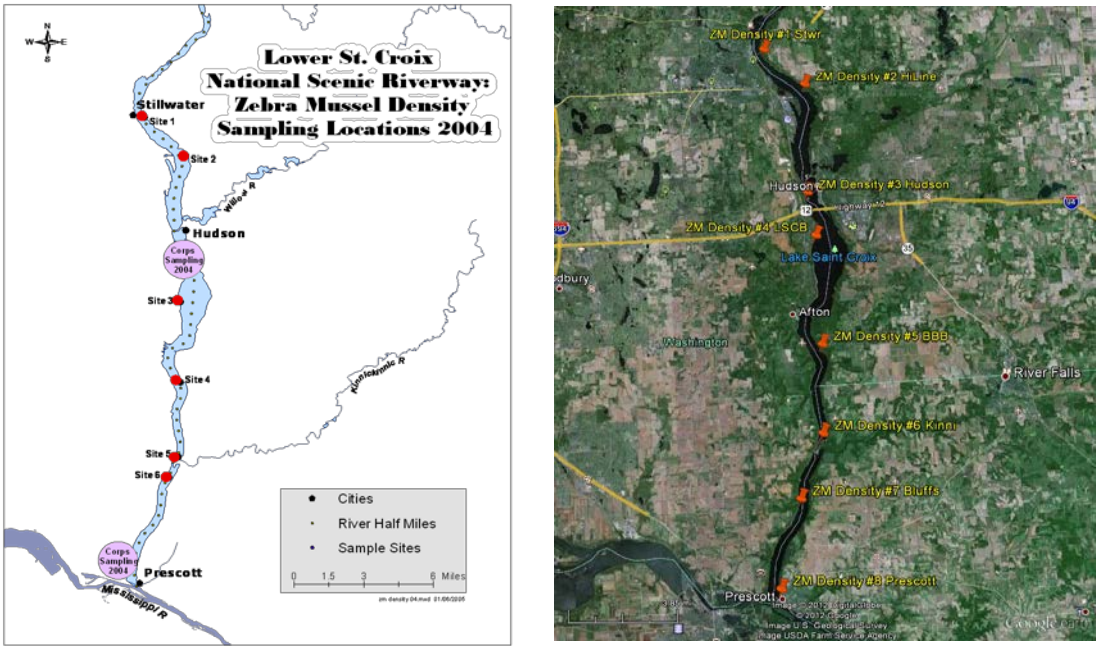
The Dive Team assisted the U.S. Army Corps of Engineers (USACE) with a long-term mussel community health assessment at UMR Pool 2. In addition, listed species such as, Higgins eye, Snuffbox and several winged mapleleaf were released at suitable mussel beds within upper Pool 2.

Finally, the Dive Team assisted Macalester College with surveying for winged mapleleaf near the downstream extent of the winged mapleleaf population near William O'Brien State Park on the St. Croix River (see Appendix A.)

Lake St. Croix Zebra Mussel Densities *(2012 USACE/NPS SOW Task 1)*

Quantitative samples were collected at seven locations (Kinnickinnic was not sample in 2012) to determine zebra mussel densities at various places within the last 21 miles of the river (Fig. 1). The locations included the Essential Habitat Areas (Hudson and Prescott) designated for the Higgins eye mussel and representative of each of the pools and narrows of Lake St. Croix from the confluence with Mississippi River, upstream to Stillwater.

Figure 1. Maps of eight long term zebra mussel monitoring sites established in 2004.



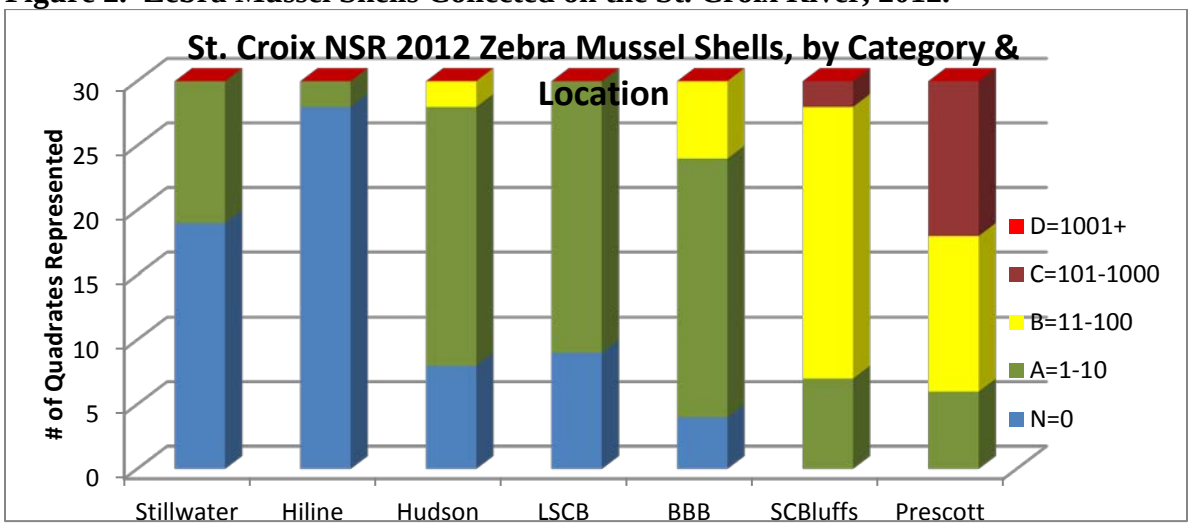
Within the location perimeter, the boat was moved to ensure full coverage of the native mussel bed. The dive boat was positioned in as close proximity as possible to previously sampled sub-sites locations via GPS. Then 30 1/8th meter-squared quadrates were sampled by first

haphazardly tossing the metal squares from the boat. Divers would follow the attached buoy line to the river bottom and collect a fingers-depth of all material within the quadrate. Returning to the boat, on-board crew members would retrieve samples from the diver and seep the substrate before placing material in one gallon zip lock bags. After all samples from the location were collected, an appropriate shore site was determined and a crew of 4-6 staff and volunteers processed each sample through 3mm screen mesh using a low pressure pump of river water. Live native mussels were identified to species and returned to the river. Any attached zebra mussels were removed and placed in Whirl-Paks with the sample. Samples were taken to the lab and frozen for later analysis. This technique (though potentially labor intensive) allows for completion of time consuming flushing of sand, mud and small organic matter on site, without tedious transport. On site processing reduces off-site storage and contamination, aids in sample preservation, and improves efficiency.

In the laboratory, sample material was thawed, removed from the baggies and spread onto a sorting tray. Larger debris was checked under handheld magnification and zebra mussels (if any) removed by hand or forceps. Next, the remaining material was rewashed in a 250 µm sieve then spread evenly throughout a dissecting scope and analyzed. Zebra mussels were enumerated and measured for length in the 2012. Length information is not included in this report, but available on request.

Samples were analyzed in the following way: zebra mussel shells were separated from what was determined to be live animals (both valves attached, shells not bleached, flesh noted, or not), Corbicula, snail and native mussel shells were also separated. All animal material was counted, except dead zebra mussel shells. These shells were estimated for size and number and the results categorized as one of five units (Fig. 2). This analysis began in 2011 and results are similar for both years, though the number of samples with 1000+ shells was absent in 2012 and the number of shells in general was reduced.

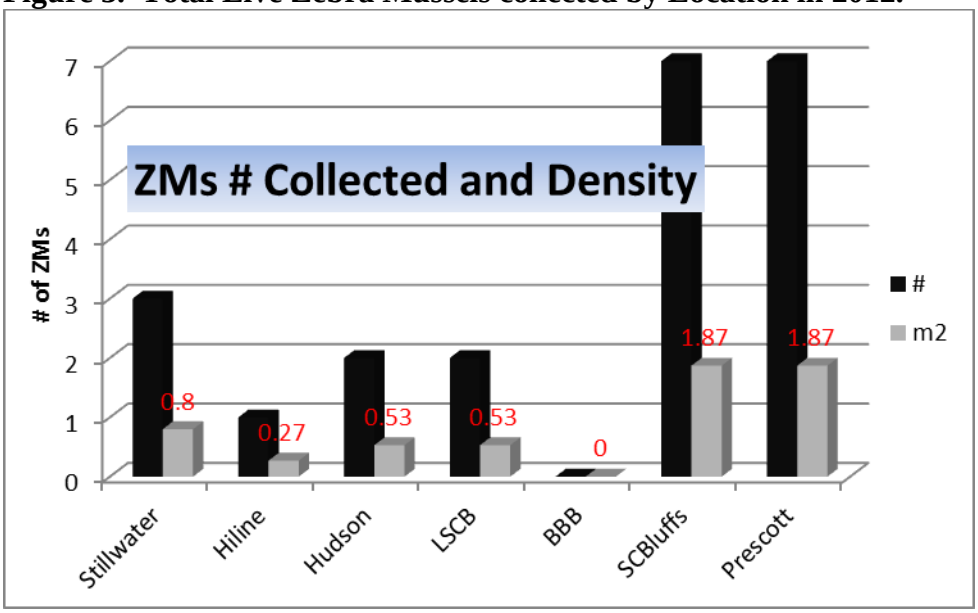
Figure 2. Zebra Mussel Shells Collected on the St. Croix River, 2012.



The most interesting and surprising result from this year's survey is the apparent continued crash of the zebra mussel population in Lake St. Croix. No live zebra mussels were found attached to

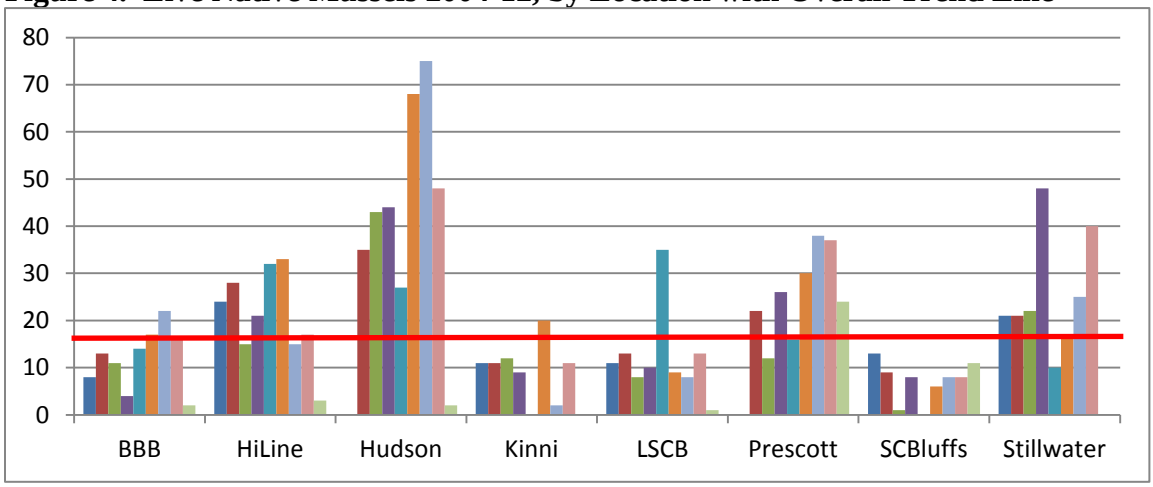
native mussels. Only 22 live zebra mussels were collected from Stillwater to Prescott, in 26.25 square meters of river bottom mussel bed (Fig. 3). This represents an average of less than 1 zebra mussel (0.84) per square meter and an obvious dramatic drop from over 12,000 in 2007 at St. Croix Bluffs Regional Park. The average size of these animals in 2012 was about a centimeter in length at all locations (minimal reproductive size, except the three larger animals found at Stillwater). At present, the reason for the decline is unknown, though a combination of fish predation (USGS Report due in 2013) and hydrology may be a reasonable conjecture (Appendix B).

Figure 3. Total Live Zebra Mussels collected by Location in 2012.



The number of Corbicula and snails collected has been noted since our first sampling year—for this year's comparison only 2009 to 2012 is presented (Appendix B.) to highlight this year's drop-off in shells collected. Native mussel shells and live mussels remain consistent with previous years, thus indicating the presence of native beds at each of the eight locations (Fig. 4). (Appendix A for more information)

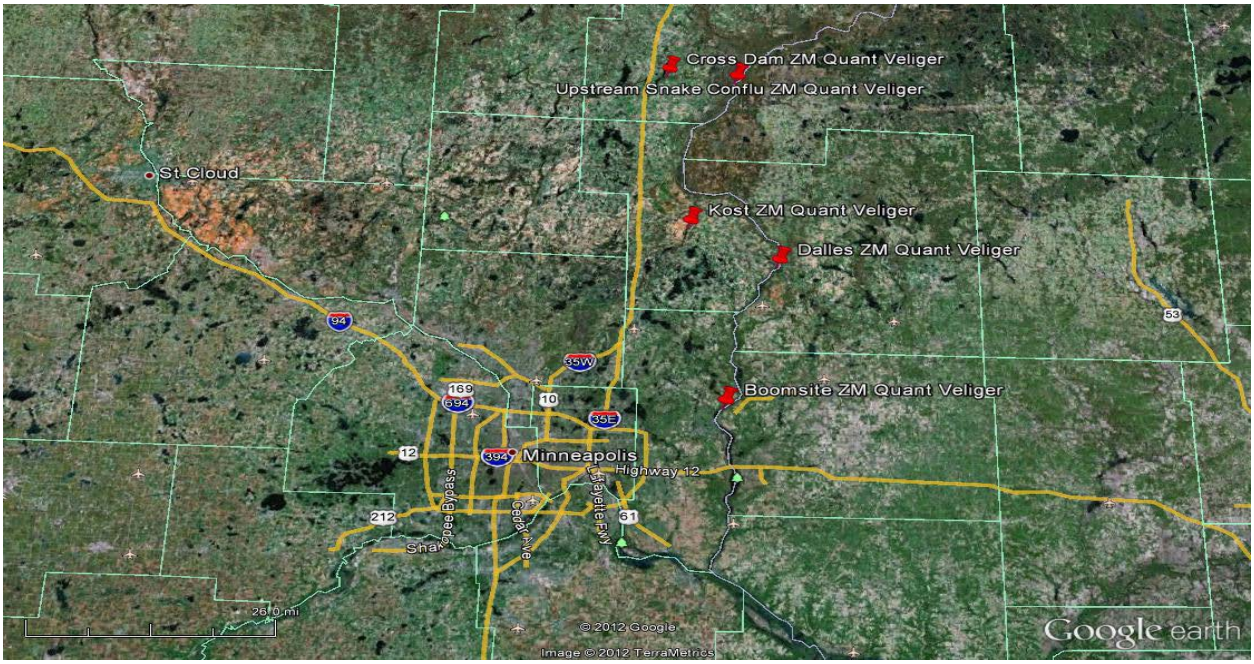
Figure 4. Live Native Mussels 2004-12, by Location with Overall Trend Line



Zebra Mussel Veliger Quantitative Monitoring *(USACOE SOW Task 2)*

A multi-agency effort to collect water samples to quantify zebra mussel is conducted in July and August each summer. Again this summer, staff from NPS visited the long-term veliger monitoring locations affecting the St. Croix River upstream of Stillwater, MN. The five NPS locations are on the Snake River's Cross Dam; the Sunrise River's Kost Dam; and the St. Croix River upstream of the Snake's confluence, Interstate Park, and the Boomsite (Fig. 5). Sites on the St. Croix below the I-94 Bridge in Hudson and Prescott, WI, are sampled by the ACOE, St. Paul District. Results are pending and will be contained in a separate report provided by the ACOE, St. Paul District office.

Figure 5. Locations of CORPS Veliger Sites in the St. Croix Basin of NPS Responsibility



Zebra Mussel Veliger Qualitative Monitoring *(2012 USACE/NPS SOW Task 3)*

The Fish and Wildlife Service continues to add to the efforts of the NPS by providing PVC samplers at locations on the river and at Wisconsin lakes at high risk to the river (Appendix B.). FWS staff deployed PVC samplers at eleven Wisconsin lakes within the St. Croix watershed and draining directly into the river. These samplers were checked 14 times from April through October. No zebra mussel juveniles were detected on any lake sampled except as noted in Bass Lake, St. Croix County, WI. Also during site visits, staff engaged in outreach related to aquatic invasive species and ways to reduce their spread. This continues to be an important additional focus of the FWS effort. The FWS monitoring also includes several samplers at marinas on the lower St. Croix. No zebra mussels have been found by passive sampler or active scuba north of the lift bridge.

Again in 2012, various lakes within the watershed and on both sides of the river were tested for veliger (both zebra and quagga mussel) presence using technology associated with the FlowCAM (Appendix C.). This microscope speeds the processing of sampling remarkably and provides surprisingly fast results. NPS staff collected samples in early September, using protocols developed by Clean Lakes, Inc. The company returns results as a table with interpretations and images of suspect or closely related organisms. The Appendix provides the lab and field tables and examples of images of note. Samples were collected using a 20cm Wisconsin tow net; a 1 to 3 meter vertical pull at three locations per lake (mid and 2 littoral), integrated, and preserved in ethanol. During these events, shoreline searches were conducted to detect for the presence of adult zebra mussels. No adults or shells were found along the shore of any lake except at Bass Lake, WI. No veligers were detected by Clean Lakes from the 15 samples provided, though several samples did show the presence of bivalves or bivalve like organisms. The images share similar characteristics with quagga/zebra mussels, yet have certain traits that suggest they are not Dreissenids. Of note, they don't have a "D" shaped shells, Maltese Cross birefringence, or have a smooth shell.

From Clean Lakes, Inc.:

> Some of the images are particularly hard to completely rule the presence of Quagga or Zebra Mussel veligers due to the particular angle the bivalve or bivalve like organism was in during cytometry, but we are confident there are no positive identifications. However, if the water bodies that we found bivalves in do not have a history of bivalves, we may want to order a PCR test on the water samples to utilize DNA to fully discount the presence of Quagga/Zebra Mussels.

Native Mussel Propagation and Management *(USACOE SOW Task 4-8)*

Appendix A has the final report of activities associated with endangered mussel management and protection on the St. Croix River in 2012. In addition, the ACOE, St. Paul District office has produced a report detailing the native mussel habitat assessment survey conducted in upper Pool 2 of the Mississippi River. This work is focused on the health of the mussel beds and the associated reintroduction of species of management concern.

APPENDIX A

St. Croix River Winged Mapleleaf Conservation Project – 2012 Report

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Spectaclecase shell collected at William O'Brien State Park

Winged mapleleaf valve collected at William O'Brien State Park

Data collection at St. Croix River at William O'Brien State Park

Live rock pocketbook collected at William O'Brien State Park

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1.0 Executive Summary

We completed three objectives to improve winged mapleleaf conservation efforts in the St. Croix River during 2012. Over the past century the winged mapleleaf has experienced reductions in range and abundance. The federal government responded by listing it as endangered in 1991. The Winged Mapleleaf Mussel Recovery Plan lists, among other activities, re-establishing winged mapleleaf populations. We undertook the following projects to assist with conservation efforts: (1) aggregate winged mapleleaf in the St. Croix River at Interstate State Park for use in propagating juveniles, (2) collect brooding winged mapleleaf for use in propagating juveniles at Genoa National Fish Hatchery, and (3) search for St. Croix River winged mapleleaf at William O'Brien State Park in hopes of finding a population that could increase genetic diversity for the juvenile propagation program. We followed standard methods to complete these objectives. SCUBA was used to aggregate and collect winged mapleleaf at Interstate State Park that were used in the 2012 juvenile winged mapleleaf propagation program. During the survey of William O'Brien State Park we observed shells of federally listed species (*Quadrula fragosa*, *Lampsilis higginsii*, and *Cumberandia monodonta*) but no live winged mapleleaf. The winged mapleleaf population we have observed at William O'Brien State Park does not appear large enough to improve in the juvenile winged mapleleaf propagation program at Genoa National Fish Hatchery.

2.0 Introduction

Winged mapleleaf (*Quadrula fragosa*), a native mussel once found throughout much of the upper Mississippi River, has become extirpated throughout most of its historic range and is in need of conservation efforts. Listed as federally endangered in 1991 (USFWS 1991) the Winged Mapleleaf Recovery Plan lists several activities needed to delist the species including re-establishing and strengthening winged mapleleaf populations (*e.g.*, using propagated juveniles). It has recently been determined that the winged mapleleaf population in the St. Croix River at Interstate State Park is at a heightened risk for extinction due to erosion of genetic diversity through genetic drift or inbreeding (Roe 2010). This project addressed some of these conservation needs through the following objectives: (1) aggregate winged mapleleaf in the St. Croix River at Interstate State Park for use in juvenile propagation efforts, (2) collect brooding winged mapleleaf from the St. Croix River for the production of juvenile winged mapleleaf at Genoa National Fish Hatchery, and (3) search for St. Croix River winged mapleleaf at William O'Brien State Park in hopes of finding a population that could increase genetic diversity for the winged mapleleaf juvenile propagation program.

3.0 Methods

3.1 Winged mapleleaf aggregation

We worked with employees of the US Fish and Wildlife Service (USFWS), National Park Service (NPS), and Minnesota Department of Natural Resources (MN DNR) to aggregate winged mapleleaf in the St. Croix River at Interstate State Park for use in juvenile mussel propagation at Genoa National Fish Hatchery, Genoa, WI. We planned to use SCUBA and snorkeling equipment in July 2012 to collect winged mapleleaf and relocate them to pre-established USFWS aggregations located just downstream of the Folsom Island wing dam, Interstate State Park.

3.2 Winged mapleleaf retrieval

Working with USFWS, NPS, and MN DNR employees we retrieved winged mapleleaf from aggregation sites at Interstate State Park, as well as finding new winged mapleleaf not in the aggregations, for use in juvenile mussel propagation. Mark Hove assisted with brooding winged mapleleaf collection dives weekly during September 2012.

3.3 Winged mapleleaf distribution

During 2012 we used SCUBA to survey sites around William O'Brien State Park in the St. Croix River in an effort to describe the size of the winged mapleleaf population at this river reach. Two divers conducted qualitative mussel surveys for six days during late summer. At each site we: (1) collected live and dead federally listed mussel species, and (2) described all the mussel species present at that site. Tissue samples from any live winged mapleleaf were to be sent to Kevin Roe, Iowa State University, to determine if the William O'Brien State Park population was genetically different from the population at Interstate State Park, St. Croix River.

4.0 Results

4.1 Winged mapleleaf aggregation

There was extended high flow in the St. Croix River during the spring and summer in 2012 that prevented collecting and aggregating winged mapleleaf at Folsom Island, Interstate State Park, St. Croix River.

4.2 Winged mapleleaf retrieval

Mark Hove worked with USFWS and NPS employees to check winged mapleleaf aggregations regularly during the fall of 2012. Displaying winged mapleleaf were collected and brought to Genoa National Fish Hatchery for use in propagating juveniles. Details on the number of gravid winged mapleleaf brought to Genoa National Fish Hatchery and channel catfish infested with glochidia were recorded by the USFWS.

4.3 Winged mapleleaf distribution

We used SCUBA to survey 26 sites for mussels in the St. Croix River around William O'Brien State Park for 6 days in late summer 2012. During this survey we observed 31 unionoid species (live and dead). Although no live winged mapleleaf were observed during this project shells were observed at three locations (Fig. 1). Additionally, we observed Higgins eye and spectaclecase at three sites and two sites, respectively (Fig.'s 2 and 3, respectively). Rock pocketbook, listed in Minnesota and Wisconsin was also observed live (Figure 4). Reaches surveyed and mussel species observed at each site is recorded in Appendix A.

5.0 Discussion

Most of our winged mapleleaf conservation efforts for this project were completed during 2012. Although high flows prevented our collecting and aggregating winged mapleleaf during the summer we found gravid animals for the propagation program in the fall. During the survey of William O'Brien State Park we observed shells of federally listed species (*Quadrula fragosa*, *Lampsilis higginsii*, and *Cumberandia monodonta*) but no live winged

mapleleaf. The winged mapleleaf population at Interstate State Park is at a heightened risk for extinction due to erosion of genetic diversity through genetic drift or inbreeding (Roe 2010). During 2010 we observed a single live winged mapleleaf at William O'Brien State Park (Hove *et al*., 2011) but no live individuals were observed during this survey. Based on our observations the winged mapleleaf population at William O'Brien State Park does not appear large enough to contribute to the juvenile winged mapleleaf propagation program at the Genoa National Fish Hatchery.

6.0 Acknowledgments

We thank the St. Paul District Army Corps of Engineers for project funding and the National Park Service for administering the funds.

7.0 Literature Cited

Hove, M., D. Hornbach, E. Griffin, K. Jackson, K. MacGregor, D. Ochi, B. Sansom, and C. Skarbek. 2011. St. Croix River Winged Mapleleaf Conservation Project – 2010 Final Report. Final report to the National Park Service, St. Croix National Scenic Riverway, St. Croix Falls, WI. 26 pp.

Roe, K. J. 2010. Report: Genetic analysis of the federally endangered winged mapleleaf mussel to aid proposed re-introduction efforts. Report to Army Corps of Engineers, Vicksburg, MS. 7 pp.

U.S. Fish and Wildlife Service. 1991. Determination of endangered status for the winged mapleleaf freshwater mussel. *Federal Register*, **56**: 28345-28349.

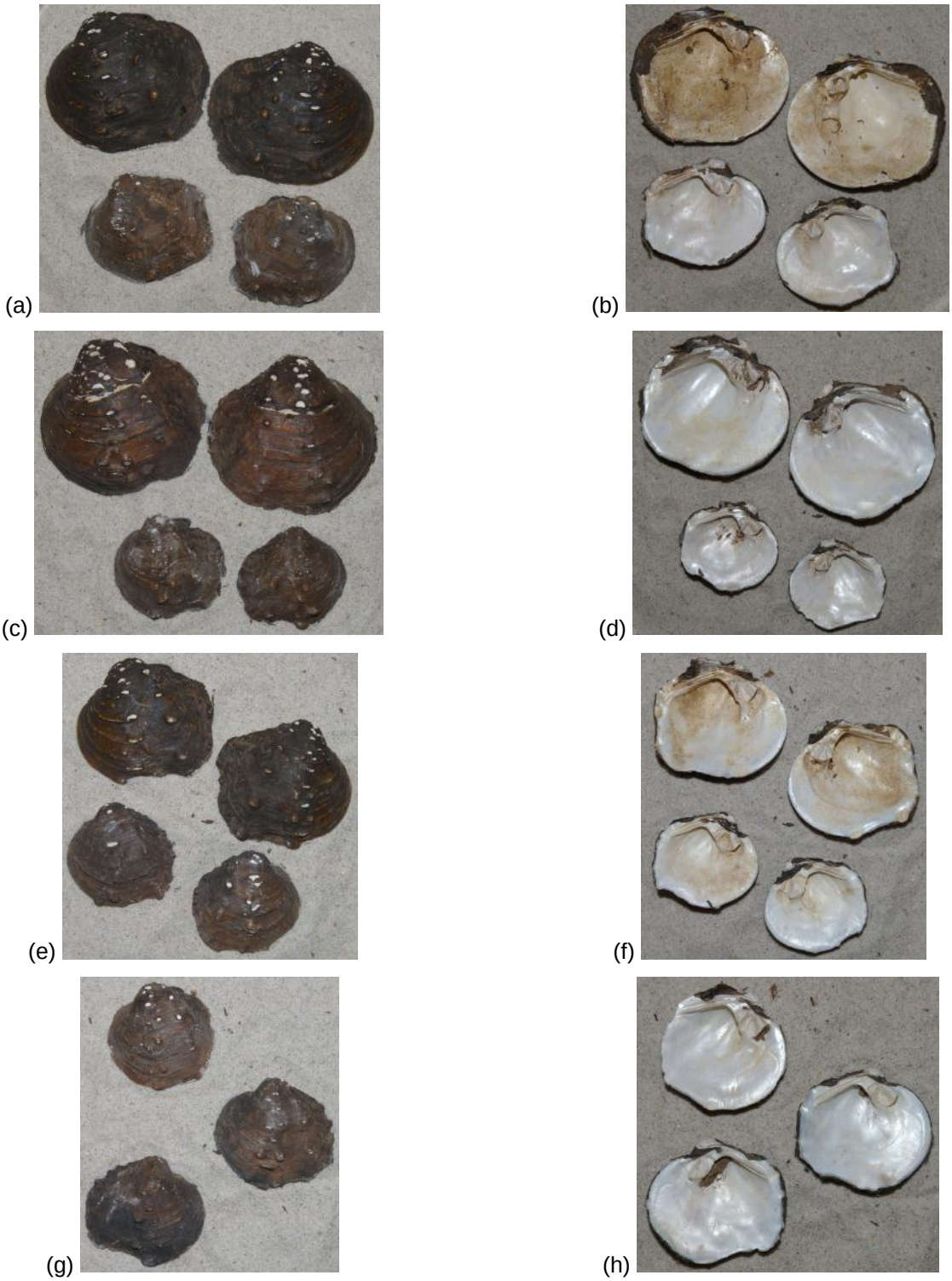
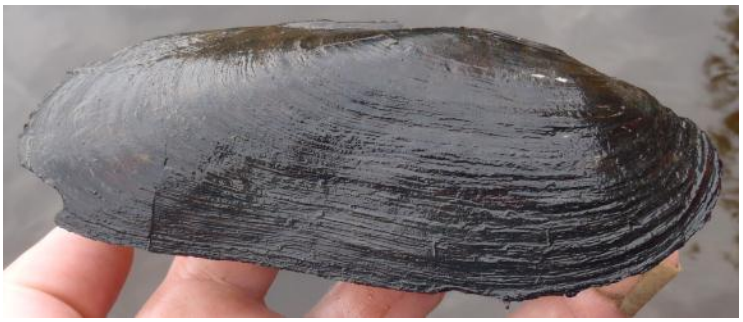


Figure 1. Empty winged mapleleaf valves collected around William O'Brien State Park, St. Croix River: (a) external view of specimens 1 and 2, (b) internal view of specimens 1 and 2, (c) external view of specimens 3 and 4, (d) internal view of specimens 3 and 4, (e) external view of specimens 5 and 6, (f) internal view of specimens 5 and 6, (g) external view of specimens 7, 8 and 9, and (h) internal view of specimens 7, 8 and 9.

Figure 2. Empty Higgins eye shells collected around William O'Brien State Park, St. Croix River: (a) external view of specimen 1, (b) internal view of specimen 1, (c) external view of specimen 2, (d) internal view of specimen 2, (e) external view of specimen 3, and (f) internal view of specimen 3.

(a)



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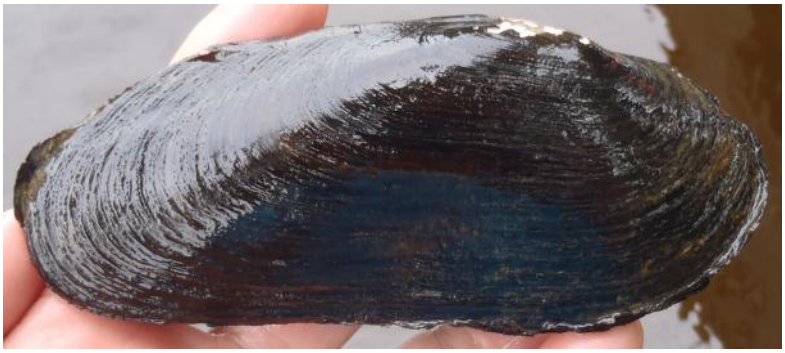


(d)

Figure 3. Empty spectaclecase shells collected around William O'Brien State Park, St. Croix River: (a) external view of specimen 1, (b) internal view of specimen 1, (c) external view of specimen 2, and (d) internal view of specimen 2.

Figure 4. Pictures of a live rock pocketbook collected at William O'Brien State Park, St. Croix River.

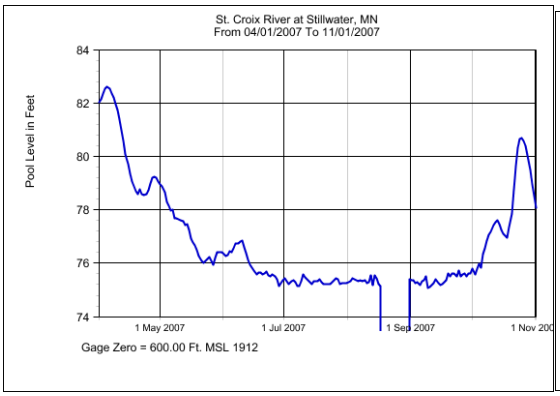
APPENDIX B

Table 1. USFWS St. Croix River Basin Zebra Mussel Monitoring and Outreach, 2012.

2012 Zebra Mussel Plate Sampler Monitoring/ANS Outreach USFWS LaCrosse, WI				
Location		# Samplers	ZM's Found-Comments	Public Contacts
Lower St Croix River:				
Afton Marina-Washington		2	Noted die-off cycle; very few on samplers late spring and into summer: noted some juveniles on samplers on fall runs.	5
Hudson Marina-St Croix		3	Marinas reported few to no zebes on boats pulled in fall which had summered in Lower St Croix. (matched my sampler info).	16
Bayport Marina-Wash.		3	Same as above	2
Stillwater Marina		3	None	12
Old Sawmill Marina		2	None	4
Wolf Marina		3	None	21
Boomsite Landing		1	None	19
Total Sites=7	17	17	ZM's found at 3 sites above.	79
Northwestern Wisconsin Lakes Monitored:				
Mallalieu-St Croix		2	None	6
Bass-St Croix		2	summer/fall-many	Notified NPS/Karns 8
Cedar-St Croix/Polk		2	None	5
Big Lake-	Polk	2	None	1
Wapagassett-Polk		2	None	17
Deer-Polk		2	None	4
Long-Polk		3	None	9
Balsam-Polk		6	None	14
Half Moon-Polk		3	None	4
Bone-Polk		3	None	17
Big Round-Polk		2	None	2
Big Butternut-Polk		3	None	14
Big Sand-Burnett		2	None	18
Clam Lake-Burnett		2	None	20
Yellow Lk-Burnett		2	None	29
Total Lakes=15		38	Numerous ZM's-Bass Lk, St Croix County	168
2012	14 trips		first trip-April 18, last trip November 7; most sampling dates =2 days	

Figure 1. USGS Hydrographs 2000-2012 St. Croix River at Stillwater.

1.



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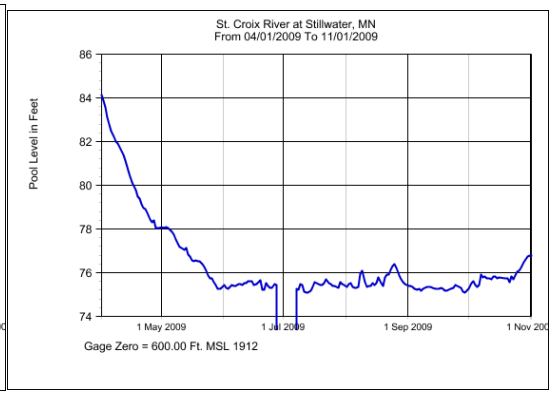

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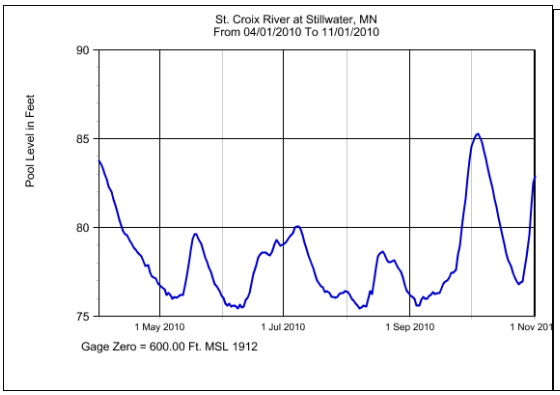

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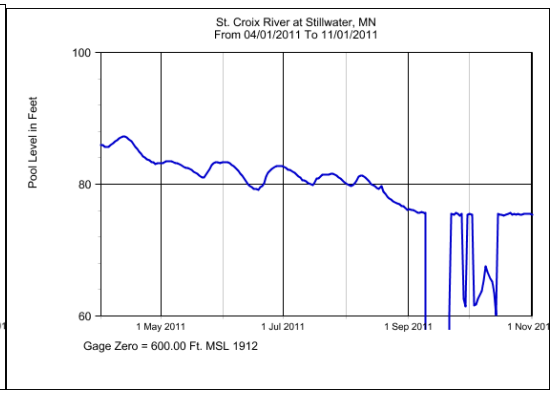

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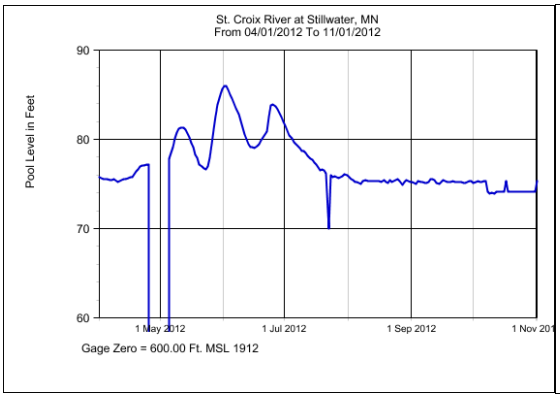

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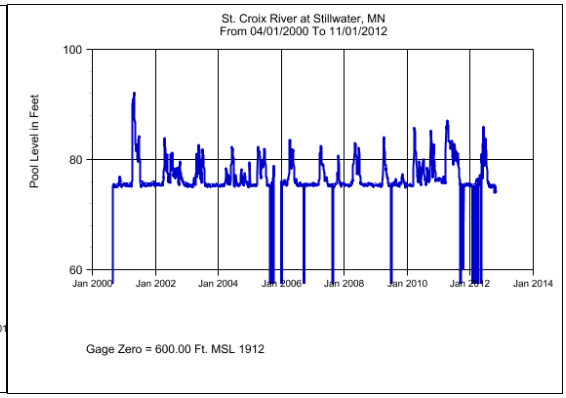


Graphs 1 and 2 represent typical summer water levels on the river as presented in the twelve years shown in Graph 6. Graphs 3-5 reflect the past three years of abnormal high water during the assumed typical zebra mussel reproduction period.

Table 2. Project Data Collected on the St. Croix River, August 2012.

By Location, ZMs & Native Mussels (Live and Shells), Asian Clams, Snails, etc.								
Location	# ZMs	Live ZM/Size (mm)	Live NM	#NM Dead	Avg. ZM Shell Size mm	byssus	# Corbicula	# Snails
Stillwater	3	17.3	0	15	14.6	4	14	36
Hiline	1	12.0	3	21	27.0	2	20	31
Hudson	2	8.5	2	44	11.9	9	11	129
LSCB	2	7.0	1	9	9.7	13	17	104
BBB	0		2	10	8.5		21	36
SCBluffs	7	9.4	11	7	9.3		29	48
Prescott	7	11.0	24	8	11.1		20	46
Totals	22	10.9	43	114	13.1		132	430
Rank of ZM # in Substrate								
	Stillwater	Hiline	Hudson	LSCB	BBB	SCBluffs	Prescott	
N=0	19	28	8	9	4	0	0	
A=1-10	11	2	20	21	20	7	6	
B=11-100	0	0	2	0	6	21	12	
C=101-1000	0	0	0	0	0	2	12	
D=1001+	0	0	0	0	0	0	0	
	30	30	30	30	30	30	30	

Figure 2. Animals Collected Other than Zebra Mussels, 2012.

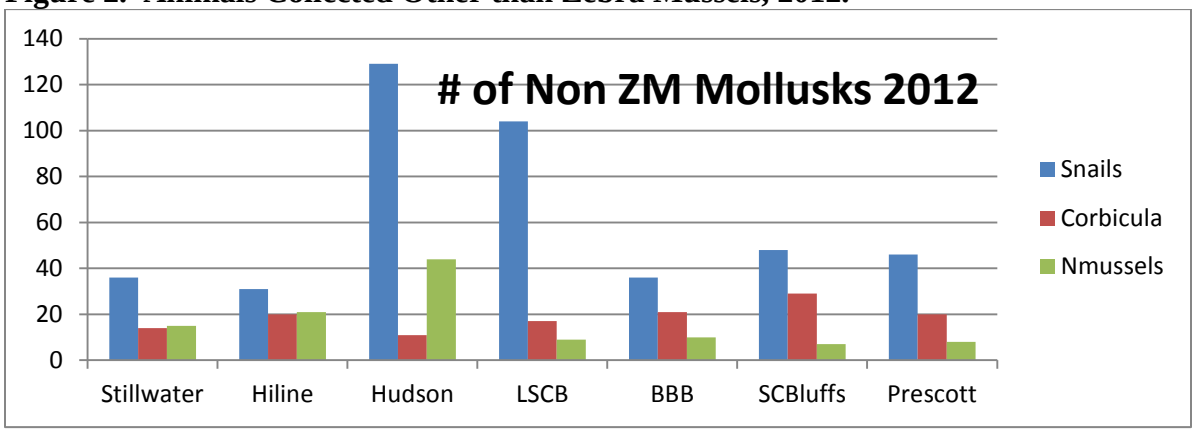


Figure 3. Snails and Corbicula Collected 2009 to 2012.

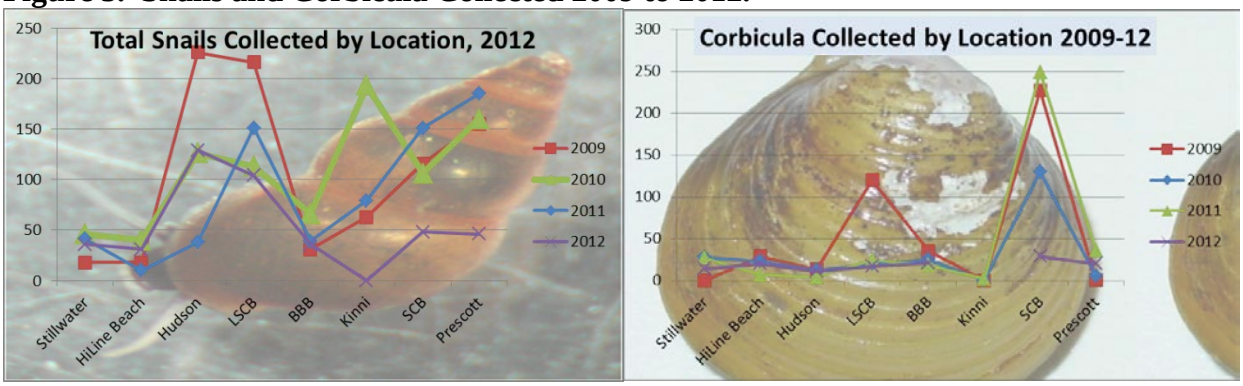


Figure 4. Native Mussel Shells collected on the St. Croix River, by Location.

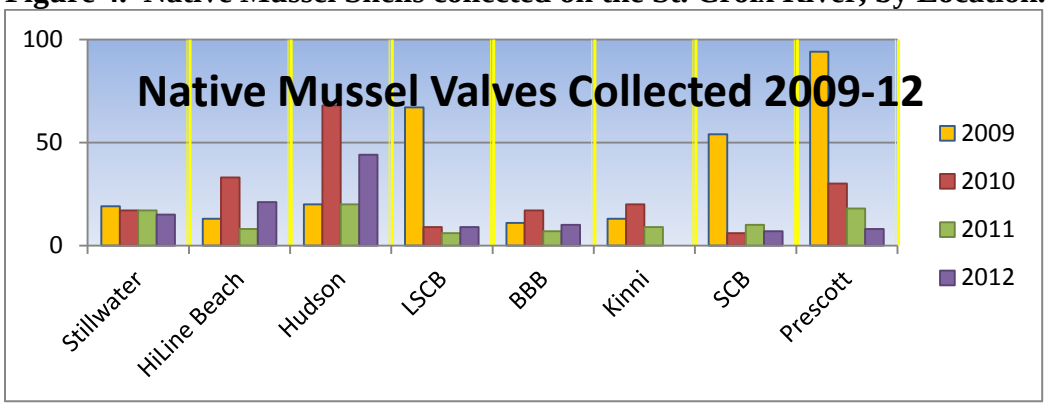


Figure 5 &6. 2012 Live Native Mussel Densities (m^2), by Location

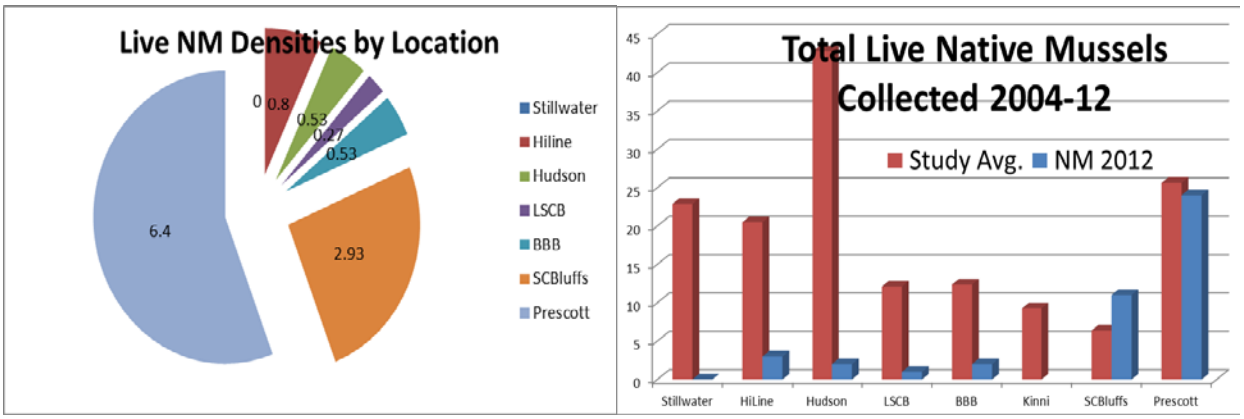


Figure 7 & 8. Live Native Mussel Means: Fig 7 compares current year to the previous year to determine between-year significant differences, while Fig 8 shows no significant change in relative abundance over the study period. Note the significant difference in 2012. This will be analyzed with future data.

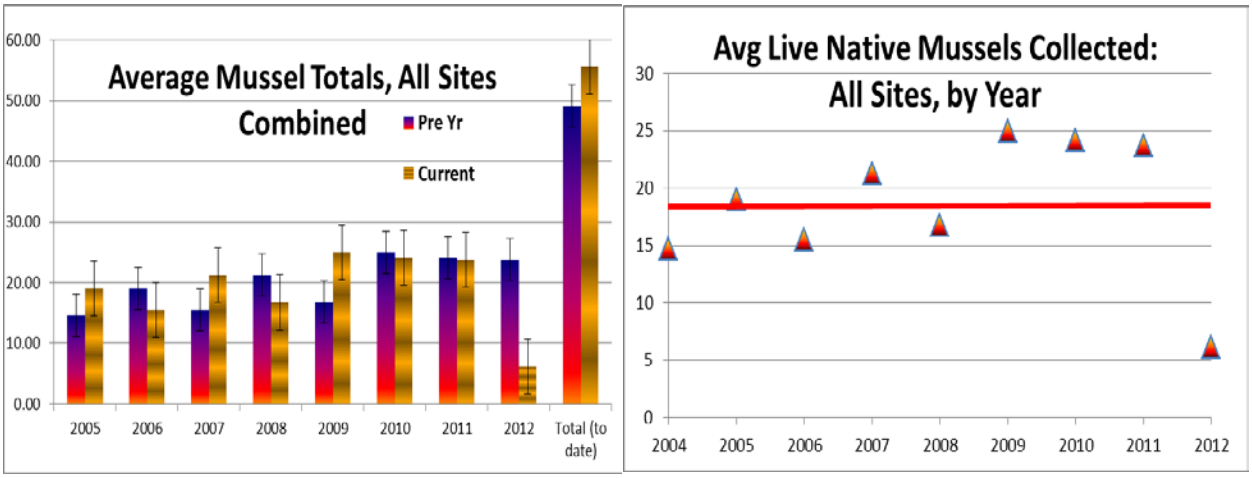


Figure 4. Zebra Mussel Densities with and without 2007 and 2008 (high density years).

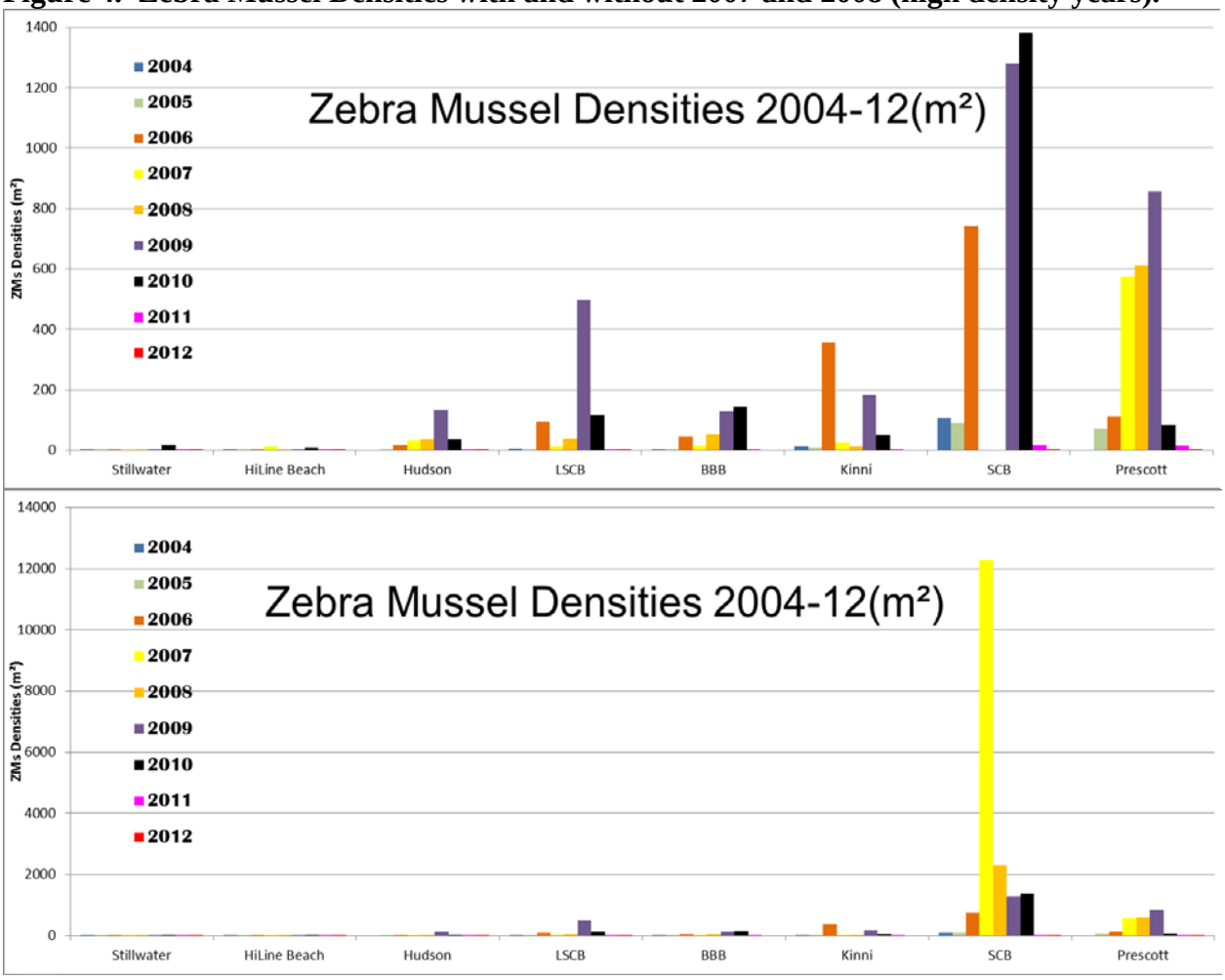
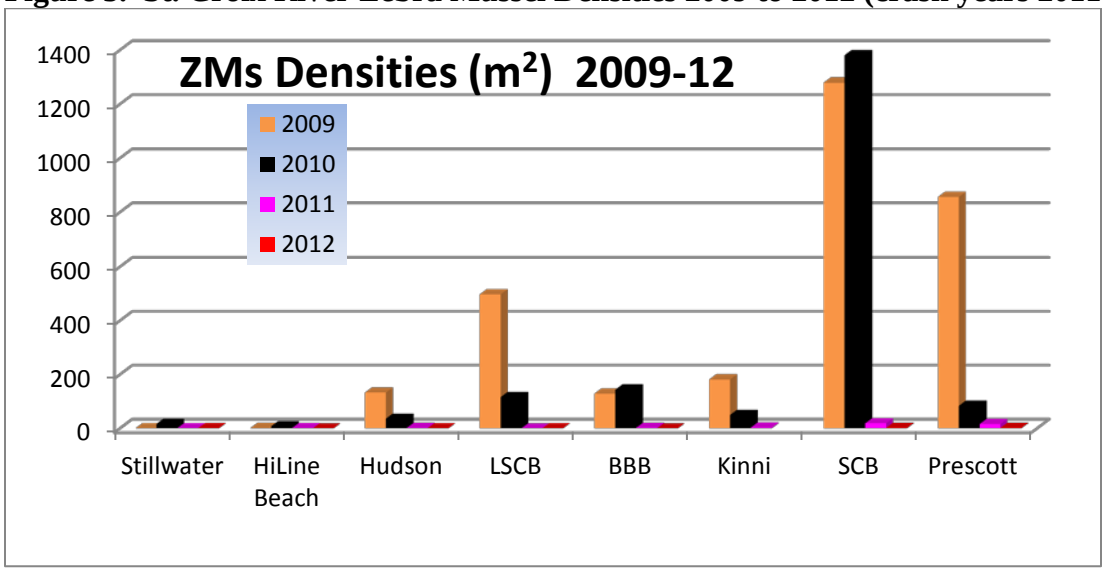


Figure 5. St. Croix River Zebra Mussel Densities 2009 to 2012 (crash years 2011-12).



APPENDIX C

Figure 1. Zebra Mussel Veliger Qualitative Sampling Locations, 2012.

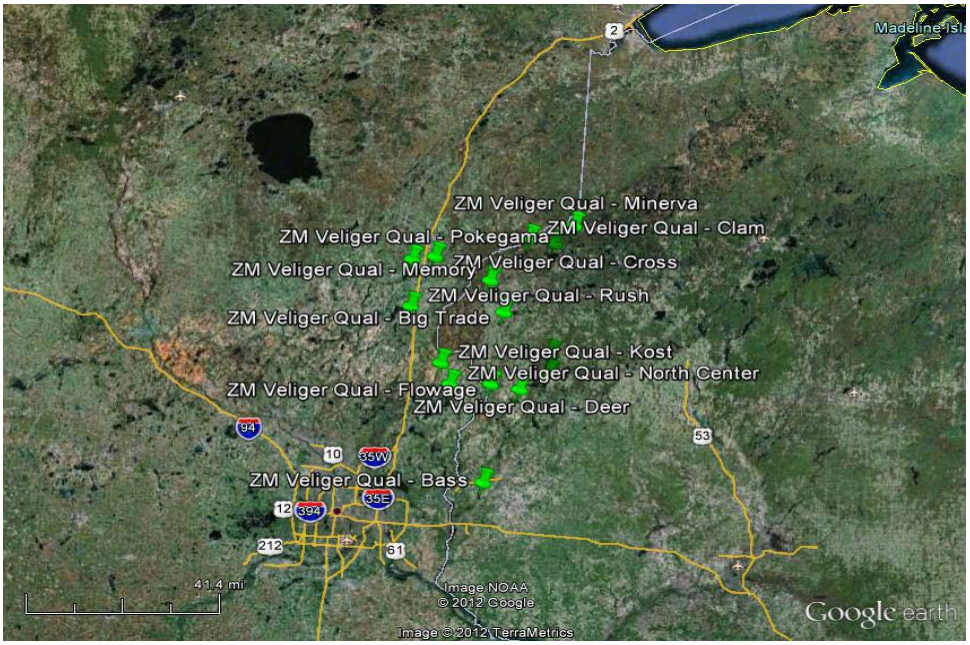


Table 1. Qualitative Sampling Locations and Results, 2012.

Qualitative Veliger Sampling, St. Croix Basin 2012				
State and County	Water Body	Date Collected	Results	Notes
MN				
Chisago County	St. Croix Flowage	9/11/2012	ND	Integrated sample*
Chisago County	Impoundment-Kost Dam (Sunrise R.)	9/11/2012	ND	above and below dam
Chisago County	North Center Lake (Sunrise R.)	9/11/2012	ND	Integrated sample*
Chisago County	Rush River	9/11/2012	ND	creek outflow only
Pine County	Pokegama Lake (Snake R.)	9/11/2012	ND	downstream most boat launch
Pine County	Cross Lake (Snake R.)	9/11/2012	ND	above dam
WI				
Burnett County	Minerva Lake (within 3 of the chain lakes)	9/12/2012	ND	Integrated sample*
Burnett County	Yellow Lake (Yellow R.)	9/12/2012	ND	Integrated sample*
Burnett County	Clam River Flowage	9/12/2012	ND	Phenomenal Algae abundance
Burnett County	Memory Lake (Wood Creek)	9/11/2012	ND	Sediment
Polk County	Big Trade Lake	9/11/2012	ND	Integrated sample*
Polk County	Bone	9/11/2012	ND	Integrated sample*
Polk County	Balsam	9/12/2012	ND	Intgrated sample*
Polk County	Deer	9/12/2012	ND	Intgrated sample*
Polk County	Bass Lake	10/3/2012	ND	Adult Samples taken by NPS/FWS

Intgrated = midlake, nearshore, littoral (often Dock) @ 1-3 meters

Figure 2. Clean Lake Veliger Sampling Results, 2012.

CLIVR 0908

CLEAN LAKES INC. Veliger Detection Report

Company Name:	St. Croix National Scenic Riverway			Contact Person:	Byron Karns
Mailing Address:	401 Hamilton St			Billing Address:	Same
City/State/Zip:	St. Croix, WI, 54024			City/State/Zip:	Same
Telephone:	715-483-3284	Fax:	715-483-3288	Project Reference Name:	St. Croix NSR
Email Address:	byron_karns@nps.gov			Project Reference Number:	SC12002-16

Client Sample Site ID	Date Sample Collected	Date Sample Received	Detailed Sample Location	Clean Lakes Sample #	Date Sample Analyzed	Amount Tested (mL)	Results	Lab Notes
St Croix Falls Flo	9/11/2012	11/5/2012	From WI Lion's Park	SC12002	11/25/2012	50	ND	Abundant organisms, minim
North Center Lake	9/11/2012	11/5/2012	South Launch	SC12003	11/25/2012	50	ND	Abundant organisms, minim
Sunrise River	9/11/2012	11/5/2012	Kost Dam Flowage	SC12004	11/26/2012	50	ND	Abundant organisms, minim
Rush Creek	9/11/2012	11/5/2012	Impundment outlflow at Field St	SC12005	11/26/2012	50	ND	Abundant organisms, minim
Snake River	9/11/2012	11/5/2012	Cross Lake Boat Launch	SC12006	11/27/2012	50	ND	Abundant organisms, minim
Snake River	9/11/2012	11/5/2012	Pokagama Outlfow Boat Launch	SC12007	11/27/2012	50	ND	Abundant organisms, minim
Wood River	9/11/2012	11/5/2012	Memory Lake Dam	SC12008	11/28/2012	50	ND	Abundant organisms, minim
Big Trade Lake	9/11/2012	11/5/2012	N End Boat Launch	SC12009	11/28/2012	50	ND	Abundant organisms, minim
Bone Lake	9/11/2012	11/5/2012	Lion's Launch	SC12010	11/29/2012	50	ND	Abundant organisms, minim
Minerva Lake Cha	9/12/2012	11/5/2012	Houman's Resort	SC12011	11/29/2012	50	ND	Abundant organisms, minim

Report Submitted by:

12/3/2012

Leif Elgethun, Laboratory Director Date

Legend

ND:	No Veligers Detected	HC:	High Concentration
D:	Veligers Detected	LC:	Low Concentration
I:	Results Inconclusive	A:	Attachments

Contact: Leif Elgethun, Veliger Detection Manager, 1770 W. State St. #125., Boise, ID 83703, (208) 301-2293, Fax: (888) 330-8602, Email: lelgethun@cleanlake.com

CLIVR 0908

CLEAN LAKES INC. Veliger Detection Report

Company Name:	St. Croix National Scenic Riverway			Contact Person:	Byron Karns
Mailing Address:	401 Hamilton St			Billing Address:	Same
City/State/Zip:	St. Croix, WI, 54024			City/State/Zip:	Same
Telephone:	715-483-3284	Fax:	715-483-3288	Project Reference Name:	St. Croix NSR
Email Address:	byron_karns@nps.gov			Project Reference Number:	SC12002-16

Client Sample Site ID	Date Sample Collected	Date Sample Received	Detailed Sample Location	Clean Lakes Sample #	Date Sample Analyzed	Amount Tested (mL)	Results	Lab Notes
Yellow Lake	9/12/2012	11/5/2012	Yellow Lake Lodge, NW Corner	SC12012	11/30/2012	50	ND	Abundant organisms, minim
Clam Lake Flowa	9/12/2012	11/5/2012	Lower Lake Launch	SC12013	11/30/2012	50	ND	Abundant organisms, minim
Balsam Lake	9/12/2012	11/5/2012	SW Launch	SC12014	12/1/2012	50	ND	Abundant organisms, minim
Deer Lake	9/12/2012	11/5/2012	From launch	SC12015	12/1/2012	50	ND	Abundant organisms, minim
Bass Lake	10/3/2012	11/5/2012	From launch	SC12016	12/2/2012	50	ND	Abundant organisms, minim

Report Submitted by:

12/3/2012

Leif Elgethun, Laboratory Director Date

Legend

ND:	No Veligers Detected	HC:	High Concentration
D:	Veligers Detected	LC:	Low Concentration
I:	Results Inconclusive	A:	Attachments

Contact: Leif Elgethun, Veliger Detection Manager, 1770 W. State St. #125., Boise, ID 83703, (208) 301-2293, Fax: (888) 330-8602, Email: lelgethun@cleanlake.com

Figure 3. FlowCam Images, 2012.

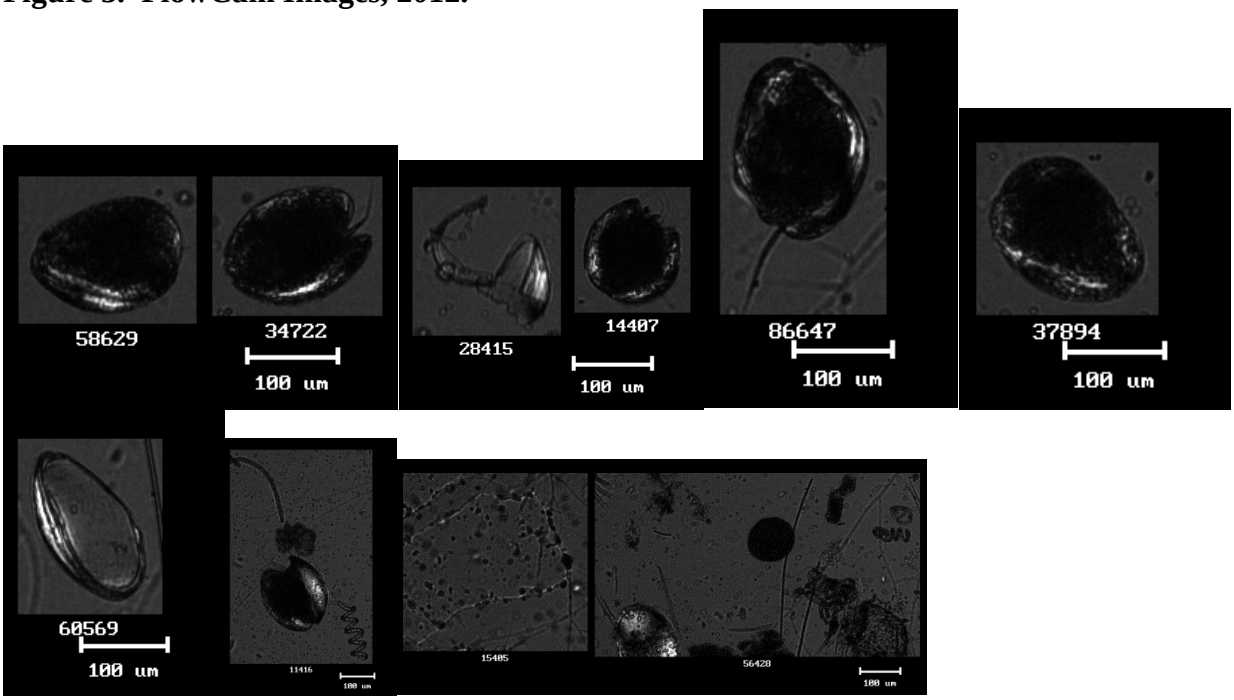


Figure 4. Veliger Sampling Data Collected, 2012.

	Veliger Presence/Absence Sampling 2012 - St. Croix River Project										
	Date	Time	Lake	Location	Water Temp C°	Pics	# aggregate samples	Littoral Pull Depth	Lake Center Pull Depth	Other Pull Depth	Note
MN	11-Sep	8:10	St. Croix Falls Flowage	From WI Lion's Park	18.6	1	3	1m	N/A	N/A	All Samples from littoral 10m from shore
MN	11-Sep	8:50	North Center Lake	South Launch	19.1	1	3	1m	N/A	N/A	All Samples from littoral 7m from shore
MN	11-Sep	9:35	Sunrise River	Kost Dam Flowage	18.6	2	3	1m	N/A	N/A	River Rt. Top of Dam east side
MN	11-Sep	10:55	Rush Creek	Impoundment outflow at Field St.	18.5	2	1	N/A	N/A	1/2m	1 minute horzonal into current at bridge
MN	11-Sep	11:30	Snake River	Cross Lake Boat Launch	20.5	1	1	1m	N/A	N/A	Sample from littoral 8m from shore
MN	11-Sep	12:20	Snake River	Pokagama Outflow Boat Launch	19:12	1	1	1.5m	N/A	N/A	All Samples from littoral 10m from shore
WI	11-Sep	13:25	Wood River	Memory Lake Dam	18.8	2	1	N/A	N/A	3m	Closed Tanier gate below dam
WI	11-Sep	14:25	Big Trade Lake	N end Boat Launch	21.5	4	2	1m	3m	N/A	none
WI	11-Sep	16:15	Bone Lake	Lion's Launch	21.6	2	2	3m	3m	N/A	mid north pool
WI	12-Sep	11:10	Minerva Lake Chain	Houman's Resort	19.5	5	4	N/A	3m	3m	Love Lake - mid; Falk Lake - mid; Gull Lake - mid and
WI	12-Sep	12:40	Yellow Lake	Yellow Lake Lodge, NW corner of lake	20.5	3?	2	3m	3m	N/A	near shore and mid lake
WI	12-Sep	13:45	Clam Lake Flowage	Lower Lake Launch	19.5	2	2	1m	3m	N/A	near shore and mid lake - very thick algae
WI	12-Sep	15:35	Balsam Lake	southwest launch	20.2	2	4	N/A	3m	N/A	mid lake western 4 pools
WI	12-Sep	16:35	Deer Lake	from launch	18.4	2	2	3m	3m	N/A	mid lake and launch bay
WI	3-Oct	13:30	Bass Lake	from launch	17.5	3	3	1m	3m	3m	H2O alternately clear/cloudy